Signal analyser and method for displaying powers of code channels with orthogonal transmit diversity

The invention relates to a signal analyser and also to a method for displaying powers of code channels of a CDMA (Code Division Multiple Access) signal.

In order to check components for third generation mobile radio systems, it is necessary to determine powers of individual code channels of which the whole signal is composed. In order to implement an evaluation of the measured powers of the individual code channels, the respective powers of the code channels are represented graphically.

For this purpose, it is known from US 6,219,340 B1 to represent the individual powers of the code channels in the form of a bar. The individual code channels are plotted in the direction of the X axis such that the code channels associated respectively with one code class are disposed situated one next to the other. The length of the bars represented for each code channel in the Y direction thereby indicates the measured power of the respective code channel. The association of the individual code channels with one code class, i.e. with a specific spreading factor (SF), is achieved in the proposed representation in that, corresponding to the lower spreading factor of the lower code class, the representation of the assigned bars for the respectively corresponding code channel of the lower code class is wider.

In the evaluation of signals with orthogonal transmit diversity, the problem exists that the powers of the individual code channels and their distribution to the antennae used are thus not detectable. In particular, it is not provided to represent those code channels, which are associated with an active antenna of an actually active code channel, en masse.

The disadvantage is produced therefrom that, for an antenna with orthogonal transmit diversity (transmission via a plurality of antennae with a code which is orthogonal for the antennae), only a part of the powers of code channels which are actually relevant for an active code channel is represented.

It is the object of the invention to produce a signal analyser and also a method for displaying powers of code channels, in which, for CDMA signals with transmit diversity, the powers of the code channels to be represented for respectively one antenna are represented completely.

The object is achieved by the method according to claim 1 and the signal analyser according to claim 3.

With orthogonal transmit diversity, the signal of an active code channel is distributed to at least two antennae. For this purpose, two orthogonal codes are generated which can be taken from the next higher code class. The lower code channel number is then assigned to antenna 1, the higher code channel number to antenna 2.

Because of generating the individual codes of the code channels for the respective code classes and because of the specification for transmit diversity that the respectively lower code channels, i.e. those code channels with the lower code channel numbers, must be assigned to a first antenna or respectively the upper code channels to a second antenna when a signal is transmitted with transmit diversity, only every second measured code channel is assigned to the code branch of the actually active antenna in the representation of an active code channel in a higher code class. This misleading assignment is corrected by the method according to the invention or respectively in an evaluation device of the signal analyser according to the invention corresponding to the production of the code channels from the Hadamard matrix. Hence in the corrected

representation, the powers of all code channels associated respectively with an actually active antenna are displayed.

The sub-claims relate to advantageous developments of the method according to the invention and of the signal analyser according to the invention.

The invention is represented in the drawing and is explained in more detail by means of the subsequent description with reference to embodiments. There are shown:

Fig. 1 a schematic representation of a section of a code tree;

Fig. 2 an overview of the assignment for the example from Fig. 1;

Fig. 3 a block diagram of a measuring system, given by way of example, with the signal analyser according to the invention;

Fig. 4 a further schematic representation of a section of a code tree;

Fig. 5A-C three further schematic representations of sections of a code tree;

Fig. 6 a graphic representation of the display device before implementation of the code channel exchange; and

Fig. 7 a graphic representation of the powers of the code channels after implementation of the code channel exchange.

In Fig. 1 a section of a code tree is represented schematically. The individual code classes are plotted in the horizontal direction, which code classes are designated with the references CC5 for code class 5, CC6 for code class 6 etc. In the represented example, the code channel with the

number 19 of the code class CC5 is intended to be active. Upon transmission of the signal with orthogonal transmit diversity, the code assigned to the code channel 19 of the code class CC5 is spread by an additional factor for distribution to the two antennae Ant1 and Ant2. The channel 19, which is actually active in code class CC5 is therefore transmitted in the code class CC6 as code channel 19 to antenna Ant1 and as code channel 51 to antenna Ant2.

The law for forming code channel numbers is as follows: the code channel number for antenna Ant1 is the base code channel number. The code channel number for antenna Ant2 is the base code channel number plus the base spreading factor.

It may be assumed in the present example that a representation of the powers of the code channels in code class CC7 is intended to be effected. For this purpose, it is firstly required to take into account the additional spreading factor on the basis of the orthogonal transmit diversity, the next higher code class CC8 being measured before the representation of the code class CC7. In accordance with the specification for generating the codes and assigning the code channels to the individual antennae with the orthogonal transmit diversity, the individual code channels, as represented in Fig. 1, are distributed to the antenna Ant1 or respectively antenna Ant2.

This means that measurement of the powers of the individual code channels is produced in the code class CC8, that the powers of the code channels 19, 83, 51 and 115 are measured for the antenna Ant1 and, for the antenna Ant2, the code channels 147, 211, 179 and 243. This assignment is produced from the specification that respectively the lower half of the channel numbers must be assigned to the antenna Ant1 and the upper half of the channel numbers to the antenna Ant2.

For the chosen example, the antenna Ant1 with the code channel 19 in code class CC5 is however actually active so that the code channels 19, 147, 83 and 211 must be assigned to the antenna Ant1 for correct antenna-wise reproduction of the measured powers, as is produced from the representation of the corresponding code branch in Fig. 1 which corresponds to a "bit-reverse representation". Therefore, a correct antenna-wise representation comprises for antenna Ant2 the code channels 51, 179, 115 and 243 which are produced from the code branch which has its origin in code class CC6 in the code channel 51.

In Fig. 2, the assignment for the chosen example from Fig. 1 is represented schematically. In the upper half of Fig. 2, the powers of the code channels are represented just as they are produced directly from the measurement in code class CC8. This leads to the fact that the code channels with the numbers 19, 51, 83 and 115 which are present in code class CC7 are represented respectively once for antenna Ant1 and are represented once for antenna Ant2 because of the orthogonal transmit diversity. For antenna Ant2, in addition the code channel number, as is represented in code class CC8 of Fig. 1, is plotted for better comprehension.

As was cited already with respect to Fig. 1, a correctly assigned representation of the antenna Ant1 in code class CC7 would have to comprise those code channels which were generated from the code channel 19 of the code class CC6 corresponding to the code branch. In the upper half of Fig. 2, these code channels are represented by the bars which are not filled in.

In order now to enforce a correct antenna-wise assignment of the code channels, the code channels associated respectively with the antenna Ant1, as is represented by the arrows in Fig. 2, are assigned according to the invention actually to the antenna Ant1. The code channels represented in grey in the upper half of Fig. 2, which code channels

should actually be assigned to the antenna Ant2, are represented correctly according to the invention correspondingly in the lower half on the right in the case of antenna Ant2.

In order that no power values of the code channels are overwritten in the implementation of the correct assignments, prior to the implementation of the representation of the individual code channels with respect to their respectively actually active antenna, a copy of the measurement result is produced. Hence all the powers of the code channels are maintained with their correct value.

The representation with respect to the actual active antenna of an active channel is of particular advantage when transmission does not take place via both antennae but only one of the two antennae is active. As can be detected directly from the upper half of the representation in Fig. 2, without the implementation of the correct assignment, both the antenna Ant1 and the antenna Ant2 would have channels with power. After implementation of the code channel exchange, there is displayed for an actually active antenna Ant1 in the lower half only power for code channels which are actually assigned to the antenna Ant1, whereas no power would be displayed for the code channels of the antenna Ant2 which are represented in grey.

A block diagram is represented in Fig. 3, which shows a signal analyser 1 according to the invention, by means of which for example the signal of a base station 2 is intended to be analysed. The signal analyser 1 comprises an evaluation device 3 and a display device 4. A CDMA signal 5 is supplied via an input connection 6 to the signal analyser 1. In the represented embodiment, the CDMA signal 5 is received via a change-over switch 8 which is connected to the signal analyser 1. Instead of the direct connection line, via which the signal 5 is transmitted, also an antenna could be connected to the input connection 6 which receives the CDMA signal 5 beamed from the base station 2 via the antennae Ant1, Ant2, or a

combiner, which generates the total signal of antenna Ant1 and antenna Ant2.

After the CDMA signal 5 of only one of the two antennae Ant1 or Ant2 is received by the signal analyser 1, the power for the code channels of that code class which is the next higher code class to the one to be represented, is determined in the evaluation device 3, which code class is established for example by an operator. In the above-described example, that would be the code class CC8 for the code class CC7 to be represented. Subsequently, a representation of the measured powers of the code channels is generated in the evaluation device 3, finally the code channels, which must be assigned to the corresponding antenna Ant1 or respectively antenna Ant2, being determined from this representation.

The thus determined powers of the code channels for the antenna Ant1 or respectively for the antenna Ant2 are subsequently supplied via a connection 9 to the display device 4. On the display device 4, a bar diagram is then preferably represented which contains the powers of the code channels for the code class to be represented, in the present case the code class CC7, the display device 4 preferably representing respectively only antenna Ant1 or antenna Ant2.

In Fig. 4, the resultant code tree for an active code channel 2 of the code class 2 is represented. Because of the orthogonal transmit diversity, the active code channel 2 of the code class CC2 is transmitted via an antenna Ant1 and an antenna Ant2, the antenna Ant1 containing the code channel 2 of the code class CC3 and the antenna 2 the code channel 6 of the code class CC3. In a representation of the measured power of the individual code channels, there should therefore be displayed, for the antenna Ant1, respectively that power of the code channels which emanate from the code channel 2 of the code class CC3. In Fig. 4, this is the entire upper half of the represented code tree. If a representation of the code class CC6 is chosen, the code channels 2, 66, 34 etc. up to 122 would therefore have

to be correspondingly represented in a correct antenna-wise representation with respect to the antenna Ant1, as this corresponds to the upper half of the code channels represented with respect to code class CC7.

For representation of the powers of the code channels in code class CC6, the power of the individual code channels in the code class CC7 must be measured with orthogonal transmit diversity, as has been described above already. Because of the assignment of the individual code channel numbers to antenna Ant1 or respectively Ant 2, it is thereby revealed that only every second code channel number of the code class CC7 is assigned to the antenna Ant1.

For representation of the power on the display device 4, the channels are sorted according to the invention such that increasing code channel numbers are disposed on the X axis. In code class CC7, the channel numbers 0 to 127 exist, the code channel numbers 0 to 63 being assigned to the antenna Ant1 and the code channel numbers 64 to 127 to antenna Ant2. The representation resulting therefrom on the display device 4 of the signal analyser 1 is represented in Fig. 6, it being assumed that respectively only noise power is measurable for the antenna Ant2. Without implementation of the code channel exchange according to the invention, a power of an active code channel is therefore measurable only for the code channels 2, 10, 18, 26, 34, 42, 50 and 58 which are represented in a dark colour in Fig. 6.

It is revealed in contrast from the code branch of the antenna Ant1 of Fig. 4 that powers, which are measurable in the code channels 66, 74, 82, 90 etc., should likewise be assigned to the antenna Ant1.

After implementation of the code channel exchange according to the invention, the image represented in Fig. 7 is produced on the display device 4, the code channels 66, 74, 82 etc. assigned originally to the

antenna Ant2 having now been represented in the region of the lower code channel numbers and hence being correctly represented antenna-wise for the antenna Ant1. In Fig. 7, powers for the code channels 2, 6, 10, 14, 18, 22, 26 etc. can therefore be detected.

In Fig. 5A, 5B and 5C, further sections of code trees for the active code channel 3 of the code class CC3, the active code channel 15 of the code class CC4 and the active code channel 20 of the code class CC5 are represented. The powers measured respectively in the code class CC7 for antenna Ant1 are, corresponding to the example from Fig. 4 explained above in detail, likewise represented in Fig. 6. For better differentiation, the thus represented code channels 3, 15, 19, 20 etc. are represented in light grey.

In contrast, Fig. 7 shows in turn a correct antenna-wise representation of all the powers in the code channels measured with respect to one antenna Ant1. For the sake of a more comprehensible representation, it was assumed in the representation of Fig. 6 that the antenna Ant2 respectively is inactive. In practice however, generally also antenna Ant2 will contribute to the data transmission. In order that the power of the antenna Ant2 occurring in the respective code channels is not overwritten by the powers of the antenna Ant1 in the code channel exchange, a corresponding storage of the powers coming from antenna Ant2 is required in advance. Such a storage can be achieved for example by copying the powers of the individual code channels, before implementation of the code exchange, into a memory.